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TYPE AND VARIABILITY IN KAFIR

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†As of April 15, 1921.
*In cooperation with School of Veterinary Medicine, A. and M. College of Texas.
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TYPE AND VARIABILITY IN KAFIR.

A. B. CONNER AND R. E. KARPER.

The purpose of this bulletin is to present data as to type and variability of certain characters in the kafir plant as obtained by statistical study. It is noteworthy that the progress heretofore made in grain sorghum improvement has been accomplished more or less at random and without definite knowledge as to procedure. A knowledge of type and variability in kafir populations and in lines successively inbred for certain characters will measure the progress to be made by intelligent breeding operations and will be of immense practical value to growers in the improvement of grain sorghums.

MATERIAL USED

The data presented are taken from material accumulated in a kafir breeding project begun in 1915, involving the measurement of material from crib-run heads and selected population material and from lines successively inbred for single characters.* In 1916 six hundred and sixty-nine crib-run standard blackhul kafir heads were measured and recorded as to:

1. Number of seed-bearing branches.
2. Length of seed-bearing branches.
3. Number of nodes to the head.
4. Length of rachis or center stem.
5. Length of head.
6. Weight of head.
7. Weight of threshed grain.

In succeeding work with progeny the following measurements were recorded:

1. Number of seed-bearing branches.
2. Length of seed-bearing branches.
3. Number of nodes to the head.
4. Length of rachis or center stem.
5. Length of head.
6. Weight of head.
7. Weight of threshed grain.
8. Height of plant.
9. Diameter of plant.
10. Number of nodes to plant.
11. Weight of green forage.

This bulletin, however, deals only with the first four pairs of characters enumerated. Eighty individual heads were selected for planting in 1917, comprising eight groups, a group representing one of the ex-

*This work was conducted at Texas Agricultural Experiment Station, Substation No. 8, located near Lubbock, Texas, this point being situated in the region adapted to grain sorghum.

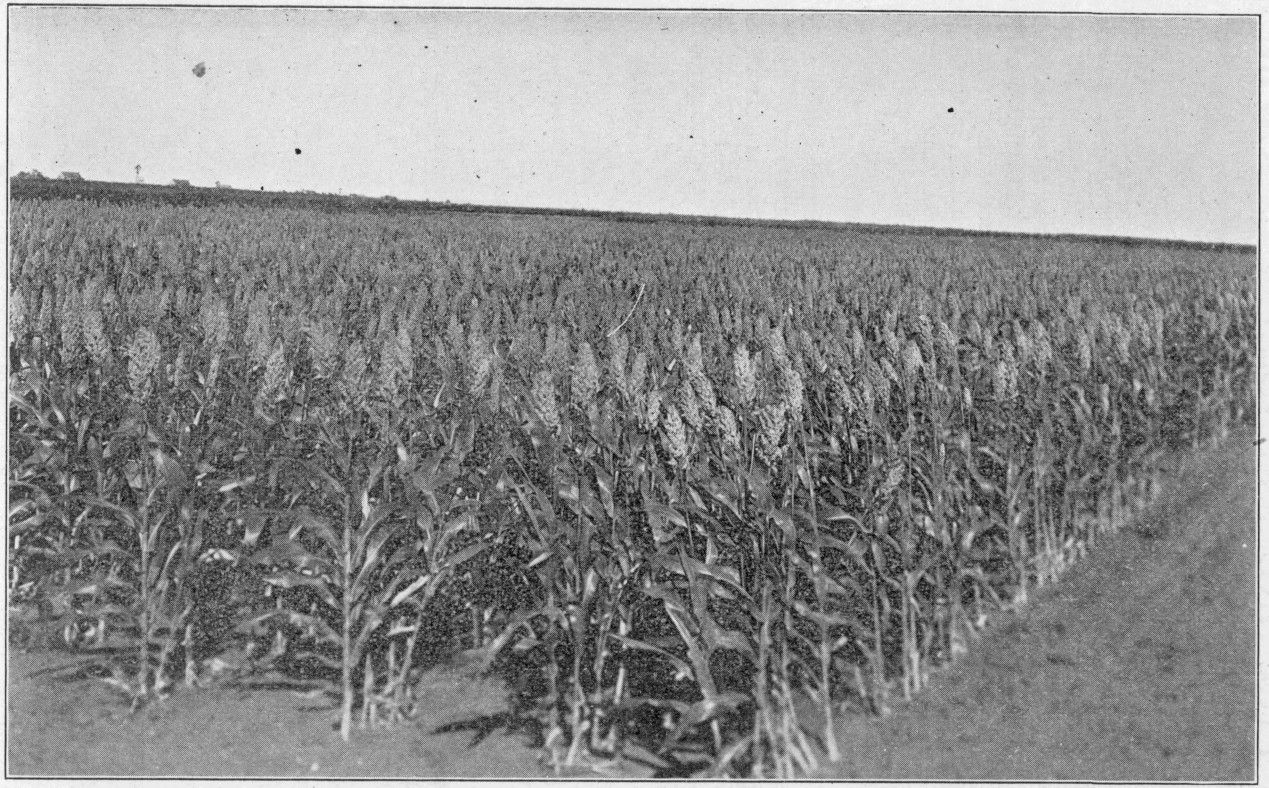


Figure 1.—Blackhul Kafir 153, showing uniformity of a pure line. This line has for three generations uniformly given higher grain yields than other lines established.

tremes of the four pairs of characters involved. For example, a ten-head group within the eighty heads selected out of the original six hundred and sixty-nine measured comprised the ten heads having the greatest number of seed branches of all those measured; likewise, a group of ten heads comprising the ones having the fewest number of seed branches were chosen. Similarly, groups were chosen for each of the four pairs of characters first mentioned. These eight groups, typifying the extremes in each of the four pairs, were grown in 1917 in head-row plats and measurements were recorded for the progeny. The selection for the 1918 planting, within a single group, comprised ten heads taken from the single row in that group whose progeny conformed to the highest standard for the particular character for which selection was made. Accordingly, the selections were made in each generation for the four-year period. The method of selection followed is clearly shown in the accompanying diagram (Figure 2). A complete set of measurements was recorded for every head without regard to the particular purpose for which the line involved was being carried.

METHODS

Progeny plantings consisted of two-rod rows with plants spaced twelve inches in the row. All main heads of the plants of half of each row were bagged, thus allowing for the bagging of a maximum of sixteen plants to the row. Occasionally, however, on account of losses due to puncture of bags, or other causes, the number of heads used and known to be self-fertilized ranged as low as ten or even eight. All bagging was done before even a pin-hole opening showed in the upper leaf sheath and thereafter any puncture of the bag or exposure of any kind resulted in the discarding of the plant in question. It may be said, however, that even during unfavorable weather (thunderstorms accompanied by wind and rain) comparatively few losses occurred. The wetting of the paper bags, however, followed by wind, did cause some losses on account of the serrated edges of the upper leaves rubbing at points of contact. Bags were removed as soon as the blooming period had passed, which could be determined with certainty by observance of the half of the rows not bagged.

All bagged heads were harvested and measured except in cases where parts were broken or otherwise damaged. In measuring, the actual count was made of the number of seed-bearing branches and the number of nodes in each head. The length of the seed-bearing branches was obtained by metric measurement of the length of one branch, taken at random from each node in the head, and averaging. The length of the rachis or center stem was obtained by actual measurement with a metric ruler in each case. In making the selections for length of rachis or center stem, the heads were selected on a basis of the proportionate length of the rachis to the length of the head.

THE DATA

The tabulation of the data for populations and for lines inbred for four generations is presented in the following tables and graphs, which show the type and variability existing in each population and line from year to year.

Table 1. Statistical constants for crib-run and selected kafir populations.

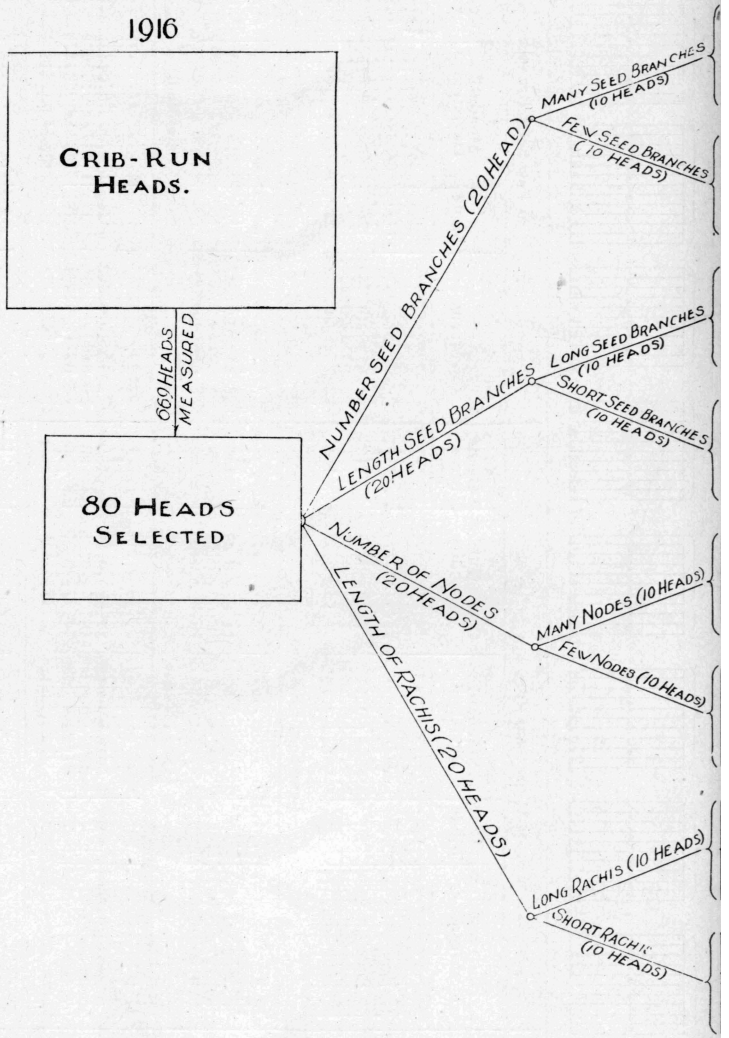
Crop	Mean	Mode	Standard Deviation	Coefficient of Variability	Number Heads Measured
Number of Seed Branches.					
1916 Crib-run Heads (1)	58.5598±0.1927	58	7.3341±0.1369	12.52±0.2375	652
1917 80 Head Population (2)	55.8846±0.1372	58	6.6439±0.0970	11.88±0.1761	1066
1917 10 Head Population (3)	56.7500±0.3496	58	5.3871±0.2472	9.49±0.4356	108
1917 10 Head Population (4)	50.7191±0.7809	58	10.9226±0.5522	21.53±1.14	89
Length of Seed Branches cm.					
1916 Crib-run Heads (1)	6.1350±0.0038	5	1.4470±0.0027	23.58±0.6532	652
1917 80 Head Population (2)	8.7964±0.0322	8	1.5624±0.0228	17.76±0.0650	1066
1917 10 Head Population (5)	8.7538±0.0962	9	1.6270±0.0680	18.59±0.80	130
1917 10 Head Population (6)	8.5200±0.0817	8	1.3541±0.0578	15.89±0.69	125
Number of Nodes.					
1916 Crib-run Heads (1)	7.2439±0.0425	7	1.6177±0.0300	22.33±0.4374	652
1917 80 Head Population (2)	6.6182±0.0029	6	1.4194±0.0020	21.44±0.3273	1066
1917 10 Head Population (7)	6.5634±0.0649	7	1.1473±0.0459	17.48±0.7207	142
1917 10 Head Population (8)	6.5200±0.0746	6	1.3551±0.0527	20.78±0.8435	150
Length of Rachis cm.					
1916 Crib-run Heads (1)	17.0552±0.0625	17.5	2.3690±0.0442	13.89±0.0025	652
1917 80 Head Population (2)	20.0929±0.0699	19.5	3.3843±0.0494	16.84±0.0245	1066
1917 10 Head Population (9)	22.2467±0.1792	23.5	3.2541±0.1267	14.63±0.58	150
1917 10 Head Population (10)	20.8918±0.1613	21.5	3.1276±0.1141	14.97±0.56	171

(1) Foundation stock.
(2) Population of 80 heads selected in equal numbers for 4 pairs of characters.
(3) Population of 10 heads selected for many seed branches.
(4) Population of 10 heads selected for few seed branches.
(5) Population of 10 heads selected for long seed branches.
(6) Population of 10 heads selected for short seed branches.
(7) Population of 10 heads selected for many nodes.
(8) Population of 10 heads selected for few nodes.
(9) Population of 10 heads selected for long rachis.
(10) Population of 10 heads selected for short rachis.

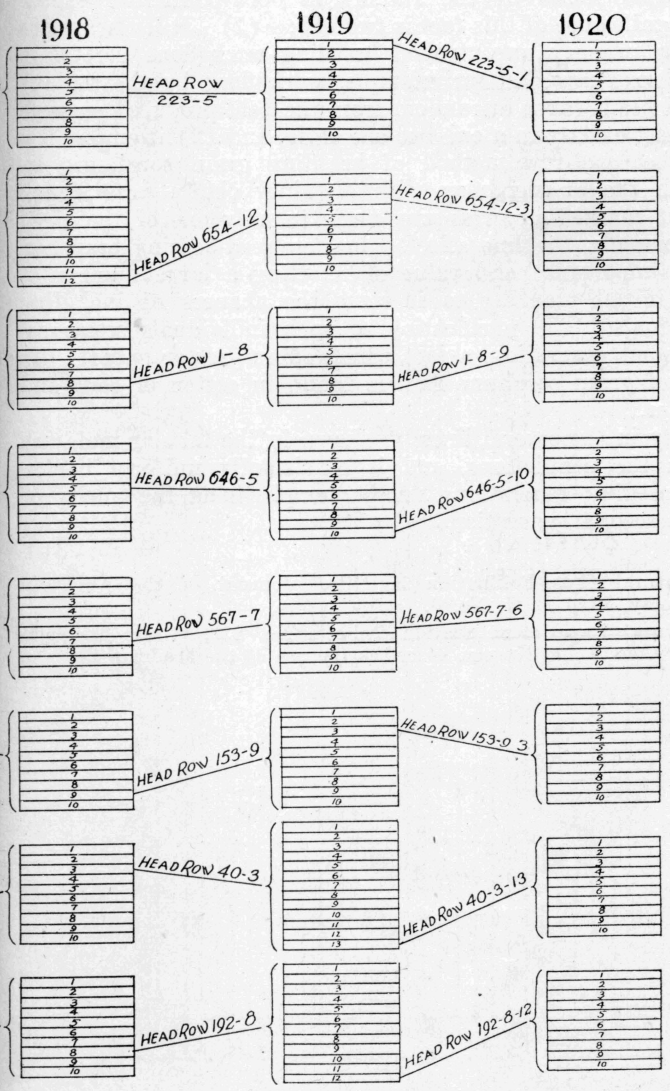
Table 2. Statistical constants showing effects of selection of type and variability in kafir.

Year	Crop	Many Seed Branches					Few Seed Branches				
		Mean	Mode	Standard Deviation	Coefficient of Variability	No. Heads Measured	Mean	Mode	Standard Deviation	Coefficient of Variability	No. Heads Measured
1916	Parent Head	74.0	.....	.....	.....	1	40.0	.....	.....	.....	1
1917	1st Generation	60.3750	.....	.....	.....	8	29.4285	.....	.....	.....	14
1918	2nd Generation	50.5664±0.2404	52	3.7884±0.1700	7.49±0.3361	113	21.8125±0.3851	25	6.4599±0.2723	29.61±1.35	128
1919	3rd Generation	53.5000±0.3961	52	3.9922±0.2801	7.46±0.3632	96	20.0370±0.4271	22	5.6991±0.3020	28.44±1.62	81
1920	4th Generation	54.3077±0.2571	52	3.8872±0.1818	7.15±0.3347	104	23.7741±0.5322	22	7.6103±0.3763	32.01±1.73	93
		Long Seed Branches					Short Seed Branches				
1916	Parent Head	10.7	.....	.....	.....	1	3.8	.....	.....	.....	1
1917	1st Generation	10.1	.....	.....	.....	11	7.1	.....	.....	.....	11
1918	2nd Generation	6.3082±0.0411	6	0.7362±0.0291	11.67±0.47	146	6.3125±0.0426	6	0.7153±0.0301	11.33±0.48	128
1919	3rd Generation	8.2727±0.0673	8	0.9931±0.0476	12.00±0.58	99	8.0217±0.0695	8	0.9888±0.0491	12.33±0.62	92
1920	4th Generation	9.0105±0.0677	9	0.9787±0.0479	10.86±0.54	95	8.6667±0.0653	8	0.9920±0.0462	11.45±0.54	105
		Many Nodes					Few Nodes				
1916	Parent Head	11.0	.....	.....	.....	1	4.0	.....	.....	.....	1
1917	1st Generation	7.1818	.....	.....	.....	11	5.7058	.....	.....	.....	17
1918	2nd Generation	6.2333±0.0601	6	1.0919±0.0425	17.52±0.7029	150	6.2308±0.0633	6	1.0709±0.0448	17.19±0.74	130
1919	3rd Generation	6.3636±0.0775	7	1.0785±0.0548	16.95±0.8862	88	6.6800±0.0707	6	1.0477±0.0500	15.68±0.76	100
1920	4th Generation	7.1887±0.0686	7	1.0471±0.0485	14.57±0 690	106	6.6211±0.0682	6	0.9860±0.0482	14.89±0.74	95
		Long Rachis					Short Rachis				
1916	Parent Head	22.5	.....	.....	.....	1	13.0	.....	.....	.....	1
1917	1st Generation	26.1	.....	.....	.....	10	19.1	.....	.....	.....	14
1918	2nd Generation	18.1393±0.1736	19.5	2.8431±0.1228	15.67±0.69	122	15.0220±0.1289	15.5	2.4102±0.0911	16.04±0.62	159
1919	3rd Generation	20.3936±0.1878	21.5	2.6994±0.1328	13.24±0.66	94	18.4213±0.2068	15 5	2.8922±0.1462	15.70±0.81	89
1920	4th Generation	19.1774±0.2002	17.5	2.8630±0.1416	14.93±0.75	93	15.8733±0.1454	15.5	1.8674±0.1028	11.76±0.66	75

DIAGRAM SHOWING METHOD
SINGL



LECTING KAFIR FOR
RS.



The foregoing tables of statistical constants seem to be quite reliable, judging from the low probable error in each case.

The eight lines involved, in every case, showed uniformity and purity in the second generation. This is in accordance with the low percentage of cross-pollination found by the authors in open-pollinated heads.[1] The practical significance of this fact is twofold: (1) It lends greater reliability to preliminary uncontrolled breeding work done heretofore with the grain sorghums, as, for example, work done by the authors in which hybrid heads taken at random from the field produced progeny segregating almost exactly in a one-two-one ratio, and (2) it emphasizes the value of the head-row method of breeding grain sorghums, by means of which the breeder may with certainty obtain pure lines.[2]

The fact that marked progress was made in only one of the eight lines involved, namely, the line selected for few seed-bearing branches, emphasizes the importance and value of selecting a large number of heads for the initial planting to increase the chances of including superior individuals. The purification of such individuals seems assured in the second generation, a fact which offers greater opportunity to the breeder of grain sorghum than is found in cotton or corn and many other crops.

The variability in the several lines, as shown in the tabular material, is less than in the populations, and is consistently uniform in the second and succeeding generations, further emphasizing the purity of the lines in the second generation.

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[1]Paper on "Natural Cross-Pollination in Milo," Journal of the American Society of Agronomy, Volume II, No. 6.

[2]Texas Agricultural Experiment Station Bulletin No. 236, "Grain Sorghum Improvement," by Conner and Karper, describes the use of the head-row method.

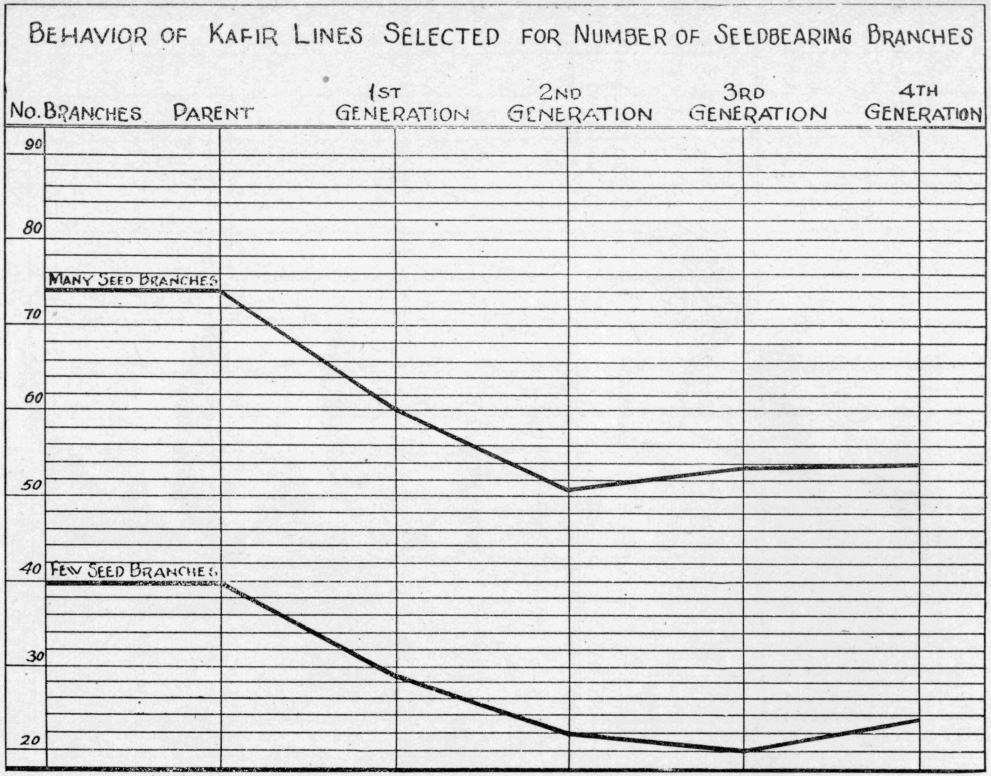
BEHAVIOR OF KAFIR LINES SELECTED FOR NUMBER OF SEEDBEARING BRANCHES
No. BRANCHES
PARENT
1ST GENERATION
2ND GENERATION
3RD GENERATION
4TH GENERATION
90
80
MANY SEED BRANCHES
70
60
50
40
FEW SEED BRANCHES
30
20

Figure 3.

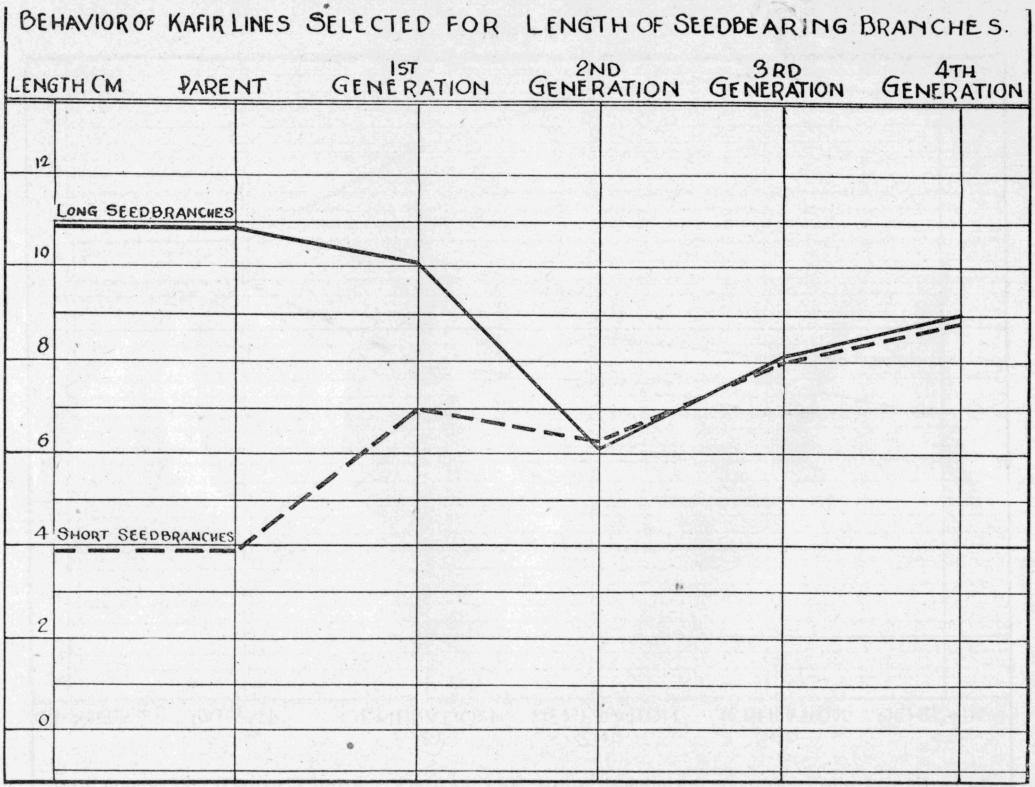
BEHAVIOR OF KAFIR LINES SELECTED FOR LENGTH OF SEEDBEARING BRANCHES.
LENGTH CM
PARENT
1ST GENERATION
2ND GENERATION
3RD GENERATION
4TH GENERATION
12
10
8
6
4
2
0
LONG SEEDBRANCHES
SHORT SEEDBRANCHES

Figure 4.

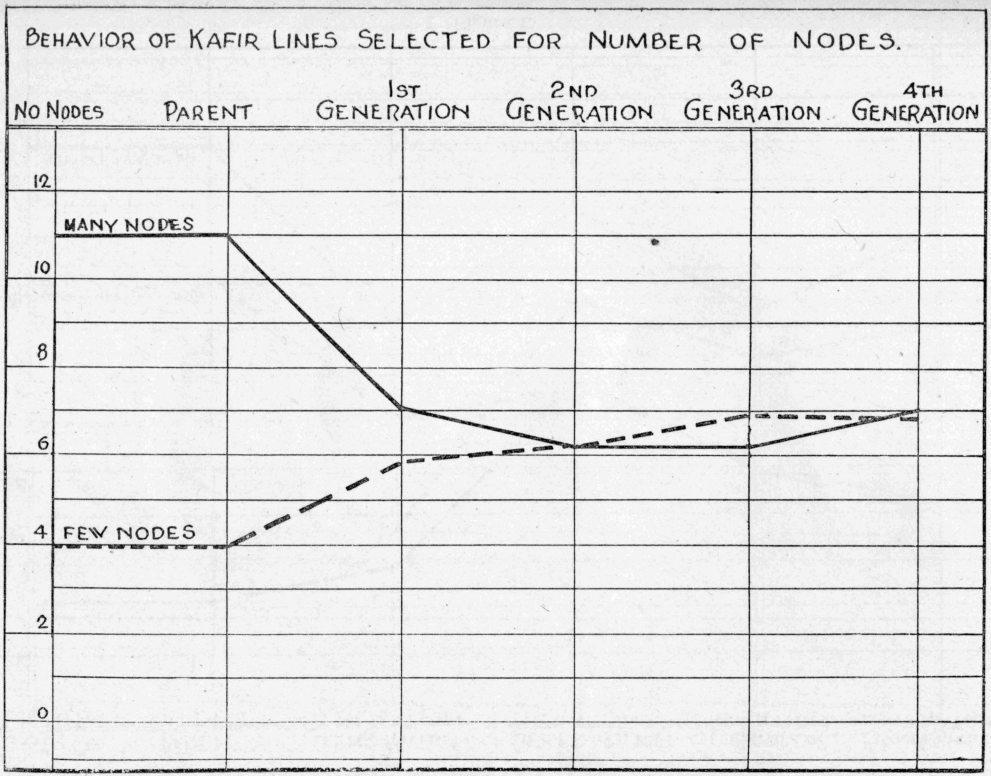
BEHAVIOR OF KAFIR LINES SELECTED FOR NUMBER OF NODES.
NO NODES
PARENT
1ST GENERATION
2ND GENERATION
3RD GENERATION
4TH GENERATION
12
MANY NODES
10
8
6
4
FEW NODES
2
0

Figure 5.

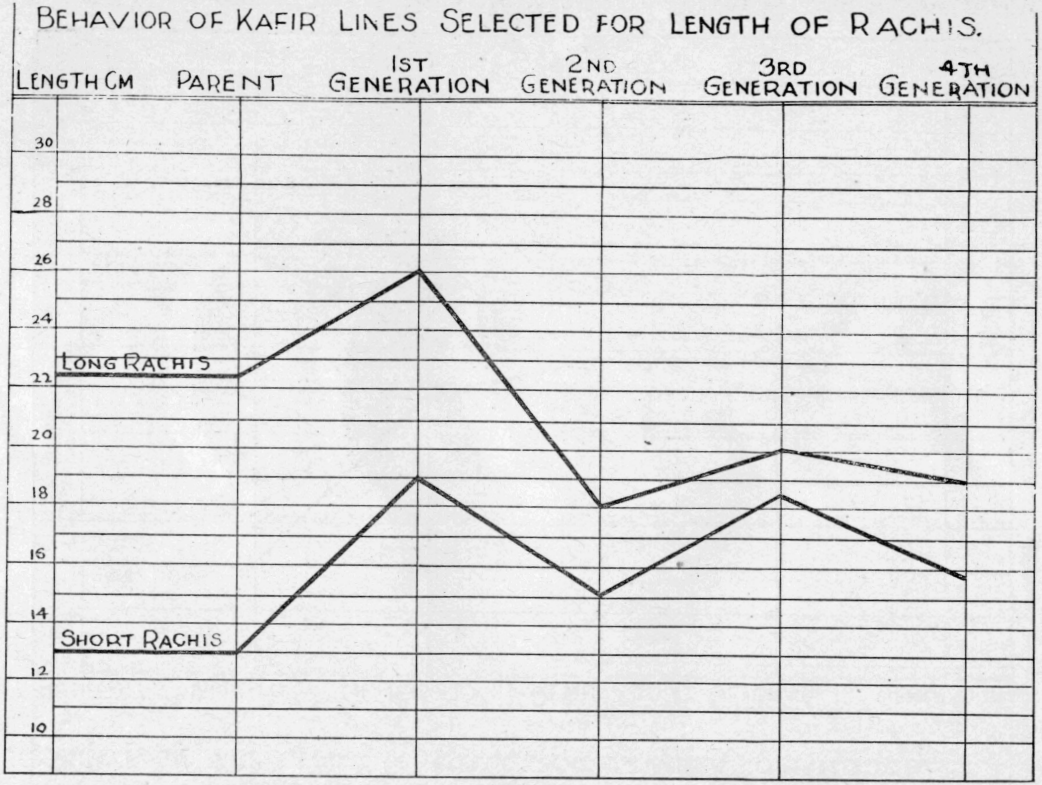
BEHAVIOR OF KAFIR LINES SELECTED FOR LENGTH OF RACHIS.
LENGTH CM
PARENT
1ST GENERATION
2ND GENERATION
3RD GENERATION
4TH GENERATION
30
28
26
24
22
20
18
16
14
12
10
LONG RACHIS
SHORT RACHIS

Figure 6.